We claim:

CLAIMS

1. A method of forming a thin magnetic film of nickel-iron alloy including from 63% to 81% iron by weight, the thin magnetic film also having a coercivity H_C and a saturation flux density B_S, the method comprising the steps of:

(a) preparing a substrate surface;

(b) preparing an aqueous plating solution having more than four and less than seven Ni^{++} ions for each Fe^{++} ion;

(c) maintaining the temperature of the aqueous solution below 20°C;

(c) passing from the substrate surface a current through the aqueous plating solution to an anode to form an electroplated layer on the substrate surface; and

(d) annealing the electroplated layer in the presence of an external magnetic field H_{EXT}.

2. The method of claim 1 wherein the preparing step (a) comprises the step of:

(a.1) forming a ferromagnetic seed layer on the substrate surface.

3. The method of claim 2 wherein the ferromagnetic seed layer comprises a material selected from a group consisting of:

a nickel-iron (NiFe) alloy, an iron-nitride-X (FeNX) alloy and a cobalt-iron-X (CoFeX) alloy wherein X comprises a material selected from a group comprising nickel, nitrogen, aluminum, rhodium and tantalum.

4. The method of claim 3 wherein the ferromagnetic seed layer consists substantially of a nickel-iron alloy containing from 64% to 81% iron by weight.

5. The method of claim 2 wherein the ferromagnetic seed layer is formed by a process selected from a group including:

sputtering, ion beam deposition, and vacuum deposition.

6. The method of claim 5 wherein the anneal step (d) comprises the steps of:

(d.1) heating the electroplated layer to a temperature of from 225°C to 275°C; and

(d.2) setting the external magnetic field intensity, H_{EXT}, to 64 kA/m oriented along the easy axis of the electroplated layer.

7. The method of claim 2 wherein the aqueous plating solution includes from 0.06 moles/liter to 0.17 moles/liter of Fe^{++} ions.

8. The method of claim 2 wherein the passing step (c) comprises the step of:

passing in from the substrate surface a current of from about 50 A/m^2 to 150 A/m^2 through the aqueous plating solution to an anode.

9. The method of claim 1 wherein the preparing step (b) comprises the steps of:

(b.1) dissolving from about 10 to about 25 g/l ferrous sulfate heptahydrate in the aqueous plating solution;

(b.2) dissolving from about 10 to about 25 g/l nickel sulfate hexahydrate in the aqueous plating solution; and

(b.3) dissolving from about 30 to about 45 g/l nickel chloride hexahydrate in the aqueous plating solution.

10. The method of claim 9 wherein the annealing step (d) comprises the steps of:

(d.1) heating the electroplated layer to a temperature of from about 225°C to 275°C for no less than about 2 hours; and

(d.2) setting the external magnetic field intensity H_{EXT} to about 64 kA/m oriented along the easy axis of the electroplated layer.

11. The method of claim 1 wherein the annealing step (d) comprises the steps of:

(d.1) heating the electroplated layer to a temperature of from about 225°C to 275°C for no less than 2 hours; and

(d.2) setting the external magnetic field intensity H_{EXT} to 64 kA/m oriented along the easy axis of the electroplated layer.

12. The method of claim 1 wherein the coercivity H_C is less than about 160 A/m and the saturation flux density B_S is more than 1.9 teslas.

13. The method of claim 1 wherein the aqueous plating solution includes from 0.06 moles/liter to 0.17 moles/liter of Fe^{++} ions.

14. The method of claim 1 wherein the passing step (c) comprises the step of:

passing in from the substrate surface a current of from 50 A/m^2 to 150 A/m^2 through the aqueous plating solution to an anode.